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INSTRUCTION MANUAL

CARRIER FREQUENCY VOLTMETER

KS-15538, L4

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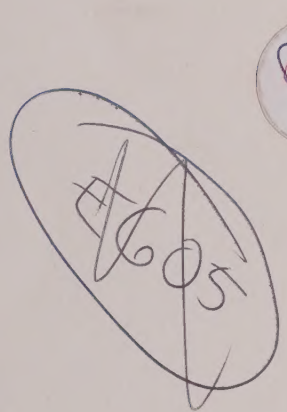

PHILCO Ford

PHILCO-FORD CORPORATION
Sierra Electronic Operation
Menlo Park, Calif. • 94025

CARRIER FREQUENCY VOLTMETER KS-15538, L4

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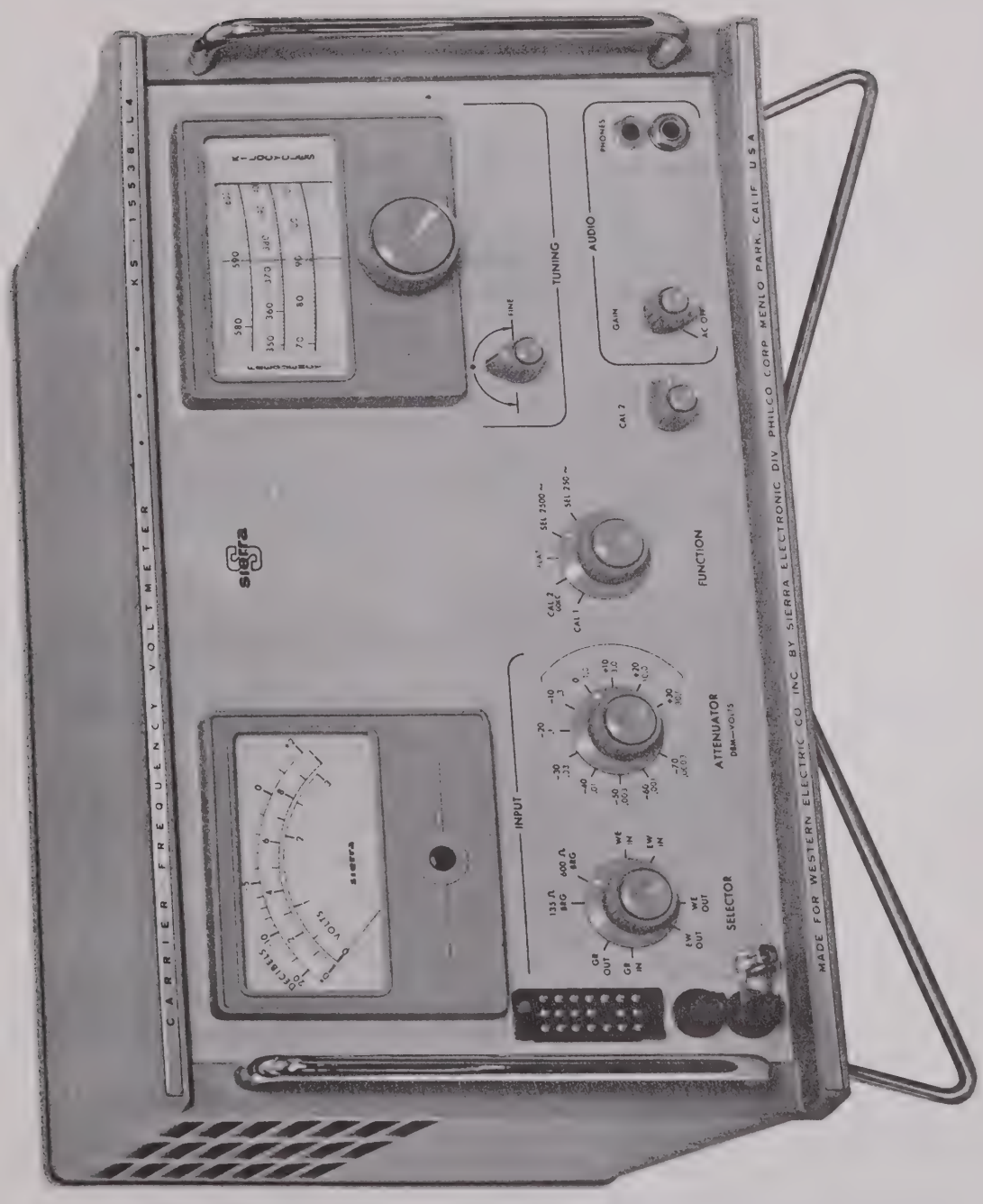


Figure 1-1. KS15538, L4 Carrier Frequency Voltmeter

SECTION I
DESCRIPTION AND OPERATING INSTRUCTIONS

1. INTRODUCTION

a. This handbook describes the KS15538, L4 Carrier Frequency Voltmeter, manufactured by Sierra Electronic Division, Menlo Park, California. Information contained in this handbook will enable the technician to perform operation, calibration and field maintenance procedures consistent with practices and recommendations of the manufacturer. The KS15538, L4 is illustrated in Figure 1-1. Full specifications are given in Table 1-1.

2. SPECIFICATIONS

FREQUENCY RANGE:

Selective Voltmeter	
Wide band (2500 cps)	10 kc to 620 kc
Narrow band (250 cps)	3 kc to 620 kc
Flat Voltmeter	1 kc to 620 kc

INPUT LEVEL RANGE:

Selective Voltmeter	-90 dbm to +32 dbm (24.5 microvolts to 30 volts)
Flat Voltmeter	-30 dbm to +32 dbm (24.5 millivolts to 30 volts)

MEASUREMENT ACCURACY:

Selective Voltmeter	±1 db (-80 dbm to +32 dbm)
Flat Voltmeter	±0.5 db (-20 dbm to +32 dbm)

SELECTIVE VOLTMETER BAND-PASS:

Wide band (2500 cps)	2500 cps (±1.25 kc) 3 db down 6000 cps (±3 kc) 30 db down 14,000 cps (±7 kc) 60 db down
Narrow band (250 cps)	250 cps (±125 cps) 3 db down 600 cps (±300 cps) 30 db down 1400 cps (±700 cps) 60 db down

DIRECT READING:	Dbm with 135 ohm and 600 ohm balanced or unbalanced lines. Volts with 600 ohm balanced or unbalanced lines.
INPUT IMPEDANCE:	
600 ohm position	20,000 ohms nominal
135 ohm position	4500 ohms nominal
WE IN position	4500 ohms nominal
EW IN position	4500 ohms nominal
EW OUT position	4500 ohms nominal
GR IN position	4500 ohms nominal
GR OUT position	4500 ohms nominal
LINE BRIDGING LOSS:	Less than 0.3 db over entire frequency range, either input impedance.
TUNING ACCURACY:	
Room Temp.	±1 kc over entire tuning range
50° F to 120° F	±2 kc over entire tuning range
SPURIOUS RESPONSE:	
Harmonic Distortion	Greater than 60 db down
Intermodulation Distortion	Greater than 60 db down
Image Response	Greater than 50 db down
Direct I-F Response	Greater than 50 db down
CALIBRATION OSCILLATOR:	100 kc ±0.02%
POWER INPUT:	105/125 volts, 50-1000 cps 60 watts
OVERALL DIMENSIONS:	
Width	17 inches
Height	10 1/8 inches
Depth	14 1/4 inches
WEIGHT:	30 lbs.
AMBIENT TEMPERATURE RANGE:	50° F to 120° F

3. DESCRIPTION

a. FREQUENCY SELECTIVE VOLTMETER. As a frequency selective voltmeter, the KS15538, L4 tunes from 3 kc to 620 kc with a sensitivity variable from 24.5 microvolts to 30 volts (-90 dbm to +32 dbm) in eleven attenuator steps. Transmission lines of 600 ohms and 135 ohms impedance may be matched by use of the LINE IMPEDANCE panel control which selects the proper internal bridging circuit. Output of the instrument is read directly in dbm by algebraically adding the reading on ATTENUATOR panel control to the output meter reading. Direct voltage readings may be made in the 600 ohm position only.

b. SELECTIVITY. Two crystal filters located between the mixer stages and the i-f amplifier provide a bandwidth of 2500 cycles or 250 cycles in frequency selective operation. Selected with the panel control marked FUNCTION, these two selectivity characteristics make the KS15538, L4 useful for complex waveform analysis as well as for general carrier system measurements.

c. FLAT VOLTMETER. In addition to its frequency selective capability, the KS15538, L4 has been designed to operate as a flat a-c VTVM with response essentially flat from 1 kc to 620 kc. In this mode of operation, a portion of the attenuator deck is by-passed so that the gain lost in switching the input signal around the mixer and i-f amplifier (approximately 60 db) is recovered by using only a portion of the input attenuation. Five attenuator steps are therefore available for flat voltmeter measurements. Range of sensitivity when used as a flat voltmeter is from 24.5 millivolts to 30 volts (-30 dbm to +32 dbm).

d. SPECIAL INPUT CONNECTOR. The instrument is supplied with a front-panel 20 pin connector and an associated multi-position input selector switch to facilitate connection of a greater number of 135 ohm balanced input circuits to the voltmeter. It is particularly designed for compatibility with built-in maintenance facilities of certain carrier equipment installations.

e. POWER REQUIREMENTS. A power source providing 105 to 125 volts, 50 - 1000 cycles is required. Power consumption is 60 watts. The line cord supplied with the unit has a standard NEMA three-prong grounded plug.

f. PHYSICAL CHARACTERISTICS. The KS15538, L4 is supplied from the manufacturer in either a standard metal cabinet 17 inches wide, 10 1/8 inches high, and 14 1/4 inches deep, or in 19-inch rack panel configuration measuring 19 inches wide, 12 7/32 inches high, and 12 1/4 inches deep. Weight of either instrument is about 30 pounds. All operating controls are mounted on the front panel.

g. GENERAL CONSTRUCTION. Modular printed circuits have been used in the voltmeter to provide direct paths and facilitate maintenance procedures. Components of each circuit are laid out on glass epoxy boards which in turn are mounted to the main chassis. Stand-offs are used to mount the circuit boards, increasing component reliability through improved cooling. Mechanical and electrical components of the local oscillator are mounted

on a separate casting to maintain physical alignment and minimize variations due to temperature change and mechanical shock. The tuning drive and dial are integral components of this assembly.

When shipped from the manufacturer, the KS15538, L4 is packed in a fiberboard shipping carton with suitable packing and re-inforcement to avoid shipping damage. To prepare instrument for use, remove the voltmeter from its shipping carton and inspect for damage. The instrument is shipped with tubes mounted. Check to ascertain that all tubes are properly seated in their sockets.

4. OPERATING CONTROLS

Prior to operating the voltmeter, a warm-up period of fifteen minutes is required to stabilize the circuitry. Power is applied by means of the line switch mounted on the audio GAIN control. The frequency dial light indicates power ON. Operating controls are listed below.

DESIGNATION	FUNCTION
AC OFF, GAIN	A-C power and AUDIO GAIN control.
PHONES	Headphone jack.
TUNING	Main tuning control (two-speed, in-out positioning).
FINE	Fine tuning control.
FUNCTION	Selects proper mode of operation (CAL 1, CAL 2, FLAT, SEL 2500~, SEL 250~).
ATTENUATOR	Calibrated selector reading amount of attenuation in db, and voltage range in volts (600Ω BRG position only).
LINE IMPEDANCE	Selects 135Ω BRG or 600Ω BRG input impedance.
INPUT BINDING POSTS	Provide means of accepting balanced or unbalanced input signals.
SELECTOR	LINE IMPEDANCE selector, selects eight inputs designated as follows: 135Ω BRG, 600Ω BRG, WE IN, EW IN, WE OUT, EW OUT, GR IN, GR OUT.
CAL 2	Selective Voltmeter GAIN control.

5. OPERATIONAL CALIBRATION

a. The KS15538, L4 is calibrated for operation using the internal 100 kc oscillator. The output from this oscillator, when FUNCTION switch S3 is in CAL 1 position, feeds a low distortion 100 kc signal to the input circuit of the voltmeter. This establishes a reference level, of approximately 0 dbm, utilizing the inherent accuracy and stability of the flat voltmeter, for the determination and adjustment of the CAL 2 (Gain) setting. Procedure for calibration follows:

1. Allow fifteen (15) minutes warm-up.

2. Set ATTENUATOR at 0 db.

3. Set FUNCTION at CAL 1.

Output meter will read approximately 0 dbm. Observe the exact reading of the meter (Example: Meter reads -0.5 dbm.)

4. Set FUNCTION at CAL 2.

5. Adjust tuning dial for maximum output meter response at 100 kc. Tune carefully in fine drive position (tuning knob pushed in) and peak with panel mounted FINE tuning control.

6. If necessary, adjust CAL 2 (Gain) panel control so that output meter reads the same level noted in the CAL 1 position (Step 3 above).

(Example: Meter reading of -0.5 dbm.) Instrument is now properly adjusted for measurement of external signals.

NOTE

An exact 0 dbm reading is not required to accurately calibrate the Model KS15538, L4. The CAL 1 check measures the output of the 100 kc oscillator accurately due to the flat voltmeter inherent accuracy and stability. It is then only necessary to set the CAL 2 level the same as read on CAL 1.

6. EXTERNAL SOURCE CALIBRATION

a. It may be desired to use an external oscillator for calibration of the voltmeter at a specific frequency in order to obtain the greatest possible accuracy. Procedure for external source calibration is given below:

(1) Set up a stable, accurately calibrated r-f signal generator with 600 ohm output, a 600 ohm attenuator, and a 600 ohm termination, preferably in the form of an indicating thermocouple. At the expense of some accuracy, a non-inductive resistor and a VTVM may be used.

(2) At the desired calibration frequency, establish a signal generator level of 0 dbm (0.775 volts across the terminating resistance).

(3) Apply established 0 dbm power level to the voltmeter input terminals.

(4) Set LINE IMPEDANCE at 600Ω BRG.

(5) Set FUNCTION at either SEL 2500~ or SEL 250~.

(6) Set voltmeter ATTENUATOR at 0 db.

(7) Adjust tuning dial and FINE panel control for maximum indication on the output meter.

(8) Adjust CAL 2 panel control for output meter reading of 0 db.

b. External source calibration for 135 ohm circuits may be accomplished in the manner described for 600 ohm measurements, substituting 135 ohm components in the external test circuits, and with LINE IMPEDANCE selector at 135Ω BRG. Voltage across the 135 ohm termination should be 0.367 volts.

7. GENERAL MEASUREMENT

a. General circuit measurement procedure is detailed in the steps which follow:

(1) Calibrate voltmeter using either procedure indicated above. (See paragraph 4 or 5.)

(2) Select mode of operation with FUNCTION switch. (FLAT, SEL 2500~ or SEL 250~.)

(3) Connect signal for measurement to voltmeter input terminals.

(4) Adjust tuning dial for maximum indication on output meter.

(5) Peak output meter with FINE tuning panel control.

(6) Set ATTENUATOR switch as required to obtain an on-scale reading.

(7) To obtain signal magnitude in dbm, add ATTENUATOR reading algebraically to that of the output meter.

b. HEADPHONE MONITORING. In the SEL 2500~ position, a headphone of any impedance with single plug may be used to continuously monitor audio signals. A panel control, GAIN, is provided to set the audio at a comfortable listening level. Output is taken from the panel jack designated PHONES.

NOTICE

With the Voltmeter calibrated and operating normally, internally generated noise will deflect the meter slightly upscale. This noise deflection should not exceed the -20 db mark on the meter and does not affect the measuring accuracy over the specified range.

Never adjust the mechanical zero set on the meter unless the power is off.

SECTION II
THEORY OF OPERATION

1. FUNCTIONAL DESCRIPTION

a. INPUT CIRCUITS. Input circuitry of the voltmeter consists primarily of switch S1 and transformer T1, and low-pass filter, the attenuation network, and switch S2 which selects the desired leg of the attenuator circuitry.

An input signal of 600 ohms or 135 ohms impedance applied to panel binding posts J1 and J2 is matched by LINE IMPEDANCE switch S1 to the input of the voltmeter in conjunction with bridging transformer T1, and with C1, R1 and R2. Input selector S1 also selects inputs from the 20-pin front panel connector through which permanent or semi-permanent connection may be made to 135 ohm long-line telephone systems. Shielded cabling carries the input signal to a two-section low-pass filter comprised of inductors L1, L2 and of capacitors C2, C3 and C4. The cut-off frequency of this filter is 620 kc. Rejection is approximately 20 db at 1100 kc.

b. ATTENUATOR switch S2, to which the output of the low-pass filter is applied, selects the portion of the attenuator network which corresponds to the panel marking in 10 db steps from -70 db to +30 db. Output of S2 is applied to FUNCTION selector S3.

In CAL 1 position, S3 feeds a 100 kc signal from the injection oscillator directly to the flat voltmeter. In CAL 2 position, the 100 kc signal is fed through a portion of the attenuator network (0 db position), through the mixer and crystal filter, FL1, to the i-f amplifier, and then to the flat voltmeter. The input signal is applied directly to the flat voltmeter in FLAT position of the FUNCTION switch, and to the mixer input in SEL 2500~ and SEL 250~ positions.

c. MIXER AND MODULATOR. Mixer V1 is essentially an amplifier, the gain of which is controlled at a rate which is equal to the local oscillator frequency (2.218 mc to 2.835 mc). The balanced modulator, consisting of CR4, CR5, CR6 and their associated components, acts as a switch which returns the cathode of V1 to a-c ground through R26 and C70. During half of the input cycle to the modulator, the balanced diodes conduct, and the modulator output is seen by C70 to be at a-c ground potential. Capacitor C70 by-passes cathode resistor R27 allowing V1 to function as an amplifier whose gain is on the order of 20 db, with R26 providing the cathode bias. During the other half of the input cycle, the diodes are non-conducting, and the modulator output is seen as a high impedance by C70. This places R27 in the cathode circuit of V1, biasing it to the point that gain through the mixer stage is about unity. Therefore, because the r-f voltage component from the local oscillator has been balanced out in the modulator, there are high order components in the mixer whose frequencies are the sum and difference of the input signal and the local

oscillator signal, but essentially no r-f voltage appears in the mixer (local oscillator signals is down 35 db to 50 db at modulator output). Therefore, the local oscillator may be tuned within 3 kc of the i-f frequency without feeding through the mixer i-f section where it would otherwise appear as a spurious signal giving an erroneous indication on the output meter. The plate tank of the mixer is tuned to the difference frequency (2.215 mc) of the mixed components. The signal is then fed through the cathode follower V2 to crystal filter FL1 or FL2.

d. LOCAL OSCILLATOR. The local oscillator, V10, which provides the switching signal for the balanced modulator, tunes from 2.218 mc to 2.835 mc, providing an intermediate frequency of 2.215 mc when mixed with 3 kc to 620 kc input signals. The circuit is a highly stable, temperature compensated Hartley oscillator, transformer coupled to the modulator. Frequency determining components are the tapped variable inductance, L11, and parallel capacitors C62, C63, C64, C65, and C93. The tuning drive mechanism is connected to the shaft of C62, the main tuning capacitor. Capacitor C65 is a compensating capacitor, providing negative temperature coefficient compensation. C93 is the fine-tuning panel control, an eccentric disc (rotor) which electrically loads and unloads a tab (stator) on the main tuning capacitor C62 for minute changes in frequency. Because C93 will rotate 360 degrees, to avoid tuning error, the fine-tuning control should be used over only 180 degrees as marked on the panel. Inductor L11 and capacitor C63 are tracking adjustments for alignment purposes. Local oscillator output is fed to cathode follower, V10B, for isolation and impedance matching.

e. CRYSTAL FILTERS. Two selectivity positions are available in selective frequency operation using crystal filters with center frequencies of 2.215 mc, and bandwidths of 2500 cycles and 250 cycles. The output impedance of the cathode follower, V2, is about 4000 ohms, matching the input of the crystal filters. Wafer S3c and S3d switch the input and output of the desired filter, to feed (SEL 2500~ SEL 250~ and CAL 2) or by-pass (FLAT and CAL 1) the i-f amplifier. The resistive T-pad network formed by resistors R38 through R43 provides a means of matching the filters to the i-f amplifier, and of balancing the filter outputs, with R42, to provide signals of equal amplitude for the i-f amplifier. Output of the T-pad is applied to the grid of V3.

f. I-F AMPLIFIER. The amplifier is comprised of two r-c coupled pentode stages, V3 and V4, which provide a combined gain of about 45 db. A single tuned grid is used to decrease the number of tuned circuit elements susceptible to temperature gain instability. CAL 2 gain control R55 provides a means of varying the i-f gain through a range of at least 3 dbm either side of the nominal gain. Output of the i-f amplifier is applied to the grid of V5, the first flat voltmeter stage, through S3b.

g. FLAT VOLTMETER OPERATION. Three r-c coupled pentode stages and an associated output meter constitute the wide band flat voltmeter section. This amplifier has a gain of about 35 db, incorporating approximately 20 db of feedback to provide gain stability. Output meter readings are stable within 0.1 db for a line voltage change of ±10 per cent, and for variations in tube g_m up to 25 per cent.

Output from the last i-f stage, V4, is carried through S3b (in CAL 2, SEL 2500~ and SEL 250~ positions) to the grid of V5, the input amplifier stage of the flat voltmeter. Coupling capacitor C36 is a relatively small value (1000 pf) and in conjunction with R62, provides a smooth fall-off in response below 1 kc. High frequency fall-off is controlled by capacitors C43 and C35 with R71, R72 and R59. The signal is further amplified in V6, and coupled to V7. Output of the three-stage amplifier is applied to the full-wave silicon diode bridge. Output meter M1 is connected across the bridge, and d-c current through the one milliampere movement is proportional to the average a-c voltage applied to the bridge.

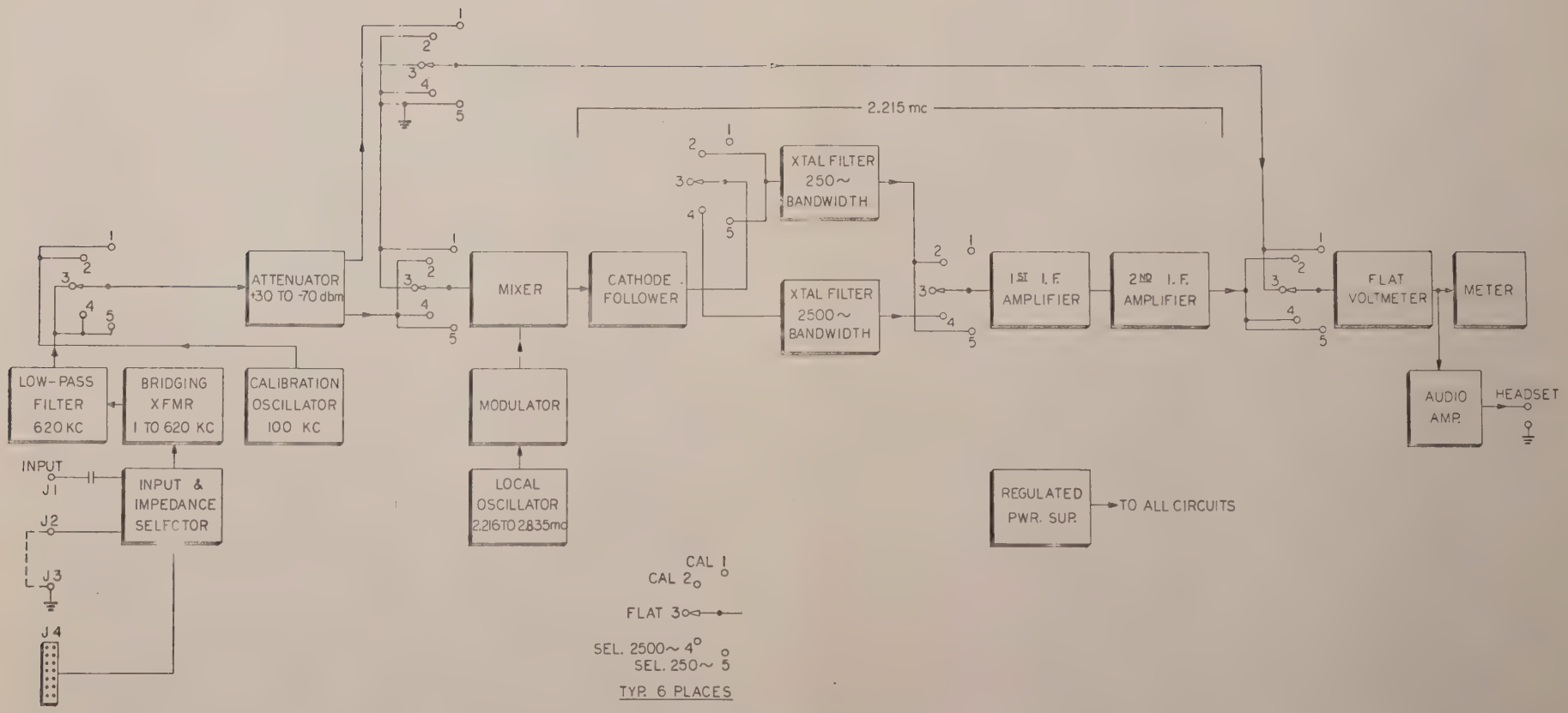
In the CAL 1 and FLAT positions of the FUNCTION selector switch S3, signals other than 2.215 mc are applied to the flat voltmeter. In CAL 1, the 100 kc signal from the injection oscillator is used to calibrate the voltmeter as a reference against which the gain through the input-mixer i-f section is set. When S3 in FLAT position, signals from 1 kc to 620 may be fed to the voltmeter. In CAL 2, SEL 2500~, and SEL 250~, the input signal is first applied to the mixer i-f section, so that the signal reaching the flat voltmeter is 2.215 mc, the i-f output frequency.

h. AUDIO AMPLIFIER. A portion of the output of the last flat voltmeter stage is coupled from a plate resistive dividing network to the audio amplifier stage. The audio component of the signal thus applied is detected by a simple crystal diode demodulator comprised of CR3, R129 or R116 and R117, L6, R74 and C47. The GAIN control, R82, determines the input level. The amplifier itself is a two-stage, twin-triode, r-c coupled circuit, the output of which is terminated at the panel mounted PHONES jack.

i. INJECTION OSCILLATOR. To provide a self-calibration capability, an internally mounted 100 kc signal source is applied in CAL 1 position of the function selector switch through the input filter and attenuator to the flat voltmeter, and in CAL 2, to the mixer i-f section. The temperature compensated 100 kc oscillator is a modified crystal-controlled Pierce circuit which generates a signal of constant amplitude. Frequency accuracy is 0.02 per cent over the specified temperature range. This signal, in addition to being used to calibrate flat voltmeter and mixer i-f levels, is also used for checking oscillator tracking and tuning dial accuracy using the high order harmonics generated at 200, 300, 400, 500 and 600 kc as reference signals. Output level is controlled with screwdriver adjusted potentiometer, R87.

j. POWER SUPPLY. The power supply is comprised of a full-wave silicon diode bridge rectifier, a series regulator, V11, and a twin triode cascade amplifier, V12. Voltage reference tube, V13, holds the grid of V12B at a constant value, thus a decrease in output voltage allows V12B to conduct more heavily because of the apparent, or relative, increase in grid voltage. The plate of V12B then becomes more negative because of the increased drop across R110, and the grid of V12A becomes more negative, decreasing the current through that stage, and increasing its plate voltage. Being directly connected to the plate of V12A, the grid of V11 will become more positive. The resulting decrease in voltage dropped across V11 will restore the original output voltage. D-c drift due to the effect of filament voltage changes in V13 is cancelled by differential action between the two sections of V12. Voltage adjustment potentiometer R113 establishes the operating level

of the series regulator, and consequently the output voltage. Supply is maintained at 225 volts, with regulation better than 0.25 per cent over a line voltage variation of 105 to 125 volts. Ripple amplitude is less than one millivolt. Input transient protection is provided with an r-c bridging network in the primary of T3.



FUNCTION SELECTOR SWITCH SHOWN IN FLAT VOLTMETER POSITION

Figure 2-1. KS15538, L4 Block Diagram

SECTION III
CALIBRATION AND MAINTENANCE

1. CALIBRATION

a. GENERAL. Calibration procedures described in this section may be conducted independently. For complete calibration to manufacturer's recommended specifications, each unit of the voltmeter should be calibrated in the sequence presented in this section. Adjustment difficulties may indicate circuit malfunction. Refer to paragraph 2 for trouble-shooting information.

b. POWER SUPPLY ADJUSTMENT. Using a d-c vacuum tube voltmeter, perform the following steps:

(1) Connect the d-c VTVM between TP1 and chassis ground.

(2) Adjust R113 for an output voltage of 225 volts.

(3) Vary line voltage from 105 to 125 volts; there should be no change in output voltage in excess of 0.25 per cent.

(4) Using an a-c VTVM and short, shielded connections, observe ripple and noise components; they should not exceed 1.0 millivolt over a line voltage variation of 105 to 125 volts. Whenever noise and ripple are less than 1.0 millivolt combined, regulation will be within specification.

c. INPUT CIRCUIT. Check the input circuit and attenuator in the following manner:

(1) Connect an r-f signal generator providing a 100 kc, 0 db signal to the voltmeter input terminals.

(2) Connect binding posts for balanced input.

(3) Set ATTENUATOR at -70 db.

(4) Set LINE IMPEDANCE to 600 Ω BRG.

(5) Set FUNCTION at SEL 2500~.

(6) Remove oscillator tube, V10.

(7) With signal generator tuned to 100 kc at 0 db level, measure from output at ATTENUATOR switch, S2, to ground using an a-c VTVM. Voltage should be -16 dbm.

(8) Set LINE IMPEDANCE to 135Ω BRG: a-c voltage should be -10 dbm.

(9) Change input binding posts from balanced to unbalanced input.

(10) Repeat steps (1) through (8).

(11) Replace oscillator tube V10.

d. FLAT VOLTMETER ADJUSTMENT. Allow fifteen minutes for warm-up. When circuits have stabilized, proceed using the method described below:

(1) Set LINE IMPEDANCE at 600Ω BRG.

(2) Set FUNCTION to FLAT.

(3) Set ATTENUATOR at 0 db.

(4) Connect a low distortion r-f signal generator to the input binding posts.

(5) Calibrate signal generator for 0 db output at 100 kc.

(6) Adjust amplifier gain at R71 for an output meter reading of 0 dbm.

(7) Tune signal generator successively to 1 kc, 3 kc, 10 kc, 50 kc, 200 kc, 300 kc, 400 kc, 500 kc and 620 kc at 0 db level, and record output meter reading for each frequency. Variation should be less than 0.5 db from 3 kc to 620 kc and less than 0.7 db from 1 kc to 620 kc.

(8) Repeat step (7) with LINE IMPEDANCE in 135Ω BRG position.

e. OUTPUT METER LINEARITY CHECK. A 600 ohm attenuator and an r-f signal are required for this check. Procedure in indicated below:

(1) Apply a 100 kc, 0 db, signal to voltmeter binding posts through external attenuator.

(2) Set external attenuator for straight-through operation, i.e., no attenuation.

(3) Set voltmeter ATTENUATOR at 0 db. Output meter should read 0 db.

(4) Attenuate the input signal in 1 db steps to -10 db, recording the output meter reading at each step. All readings should be within ±0.2 dbm of the actual attenuated input level.

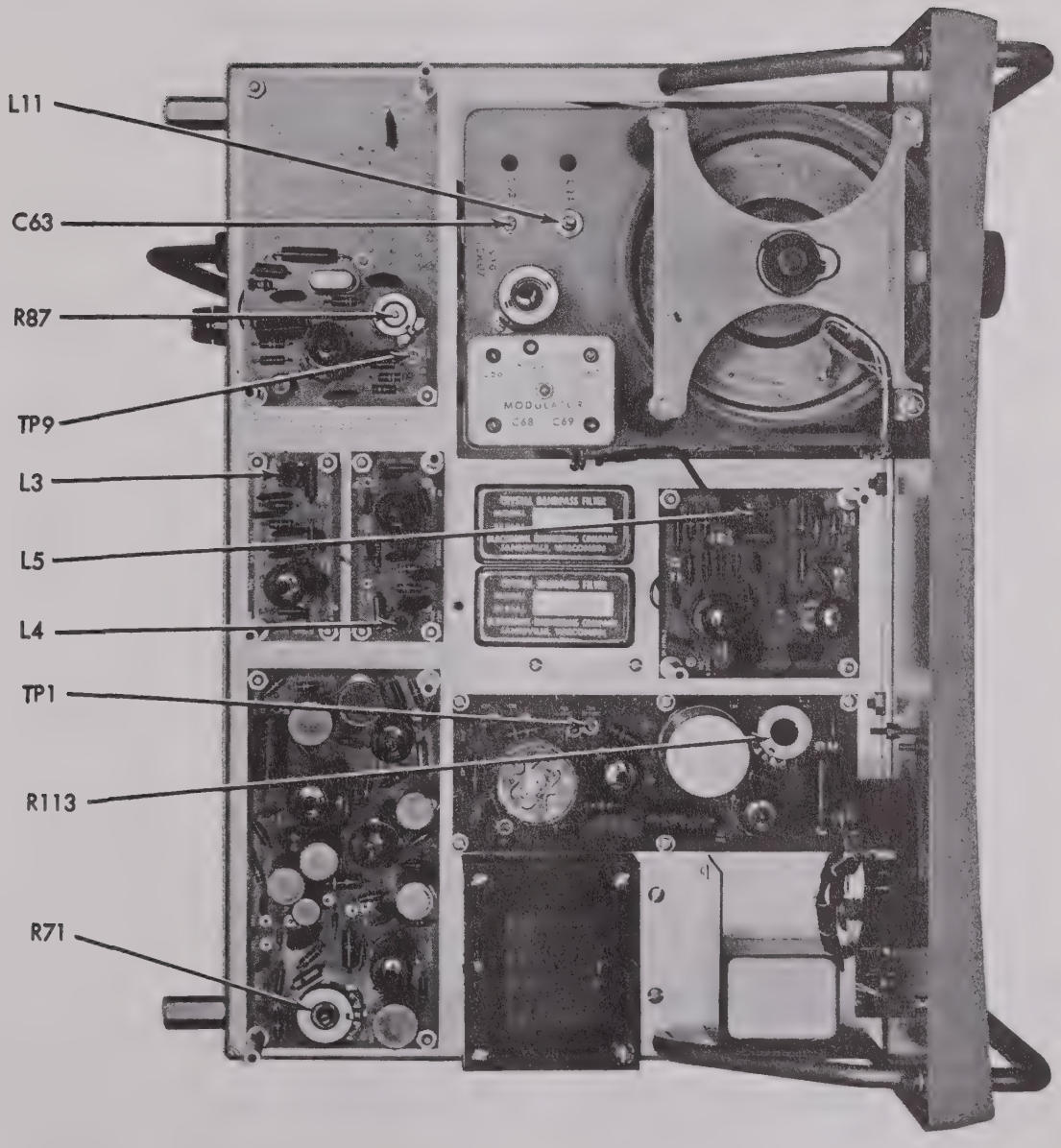


Figure 3-1. KS15538, L4 Inside, Top View

(5) Increase attenuation to -15 db. Output meter should read within ±0.5 dbm.

(6) Increase attenuation to -20 db. Output meter should read within ±1.0 dbm.

f. MIXER I-F PRELIMINARY ADJUSTMENT. Initial adjustment procedures for the mixer i-f section are listed below:

(1) Set FUNCTION to SEL 2500~.

(2) Set ATTENUATOR at 0 db.

(3) Set CAL 2 fully clockwise.

(4) Connect a jumper from binding post J1 to the output arm of S2c.

(5) Feed a 2.215 mc signal from an external r-f source to the input of the voltmeter at a level which will give half-scale deflection of the output meter.

(6) Tune L3, L4 and L5 progressively for maximum meter indication. Reduce input signal as required to maintain half-scale indication.

g. LOCAL OSCILLATOR ADJUSTMENT. Following fifteen-minute warm-up period, track the local oscillator in the following manner:

(1) Set FUNCTION to SEL 2500~.

(2) Set ATTENUATOR at 0 db.

(3) Set FINE tuning control at midpoint.

(4) Place 3 kc tuning dial mark on indicator hairline.

(5) At 0 db level, feed 3 kc signal to voltmeter, and tune L11 for maximum meter deflection.

(6) Place 620 kc tuning dial mark on indicator hairline.

(7) At 0 db level, feed 620 kc signal to voltmeter, and tune C63 for maximum meter deflection.

(8) Repeat steps (4) through (7) as needed to set upper and lower frequency extremes.

(9) Should the 150 kc to 450 kc segment not track within 0.5 kc, bend the serrated plates of C62 to improve tracking to specified tolerance (0.5 kc).

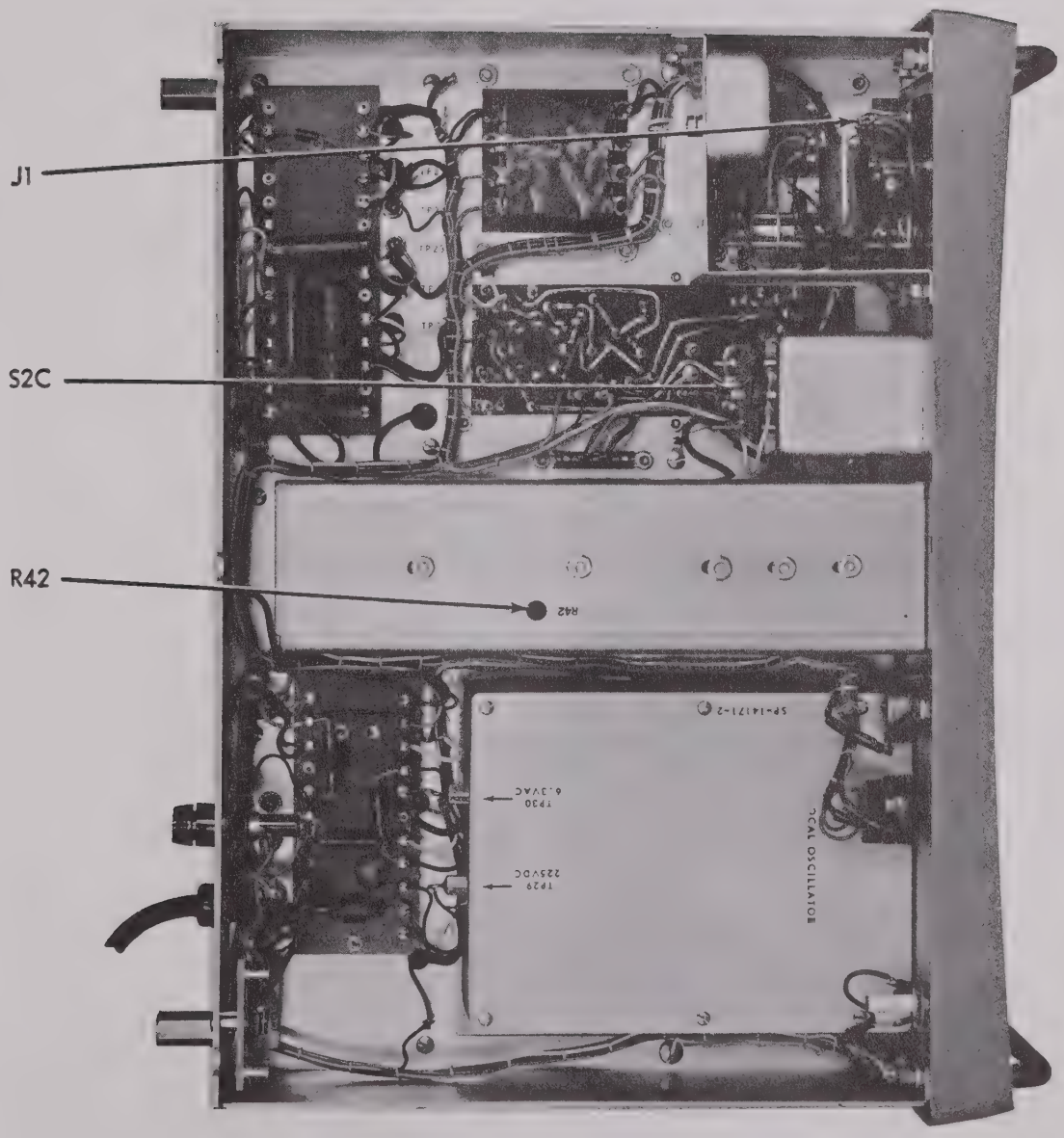


Figure 3-2. KS15538, L4 Inside, Bottom View

h. MODULATOR ADJUSTMENT. Balanced modulator adjustment requires an oscilloscope; procedure is described below:

(1) Turn instrument on; allow fifteen minutes for circuit to stabilize.

(2) Set FUNCTION to SEL 2500~.

(3) Remove modulator cover, and with the oscilloscope read the r-f envelope amplitude alternately at C66 and C67, adjusting R100 until the two amplitudes are equal.

(4) Replace the modulator cover, set the frequency dial at 3 kc, leaving FUNCTION set at SEL 2500~.

(5) Tune C66, C67, C68, and C69 for minimum signal indication, correcting each interaction until the residual output meter reading is as low as obtainable. Spurious harmonic generation should be at least 63 db down. Tune the frequency dial to 5 kc; residual reading should not exceed -20 db. A non-metallic screwdriver must be used in this procedure.

NOTE

The meter reading during this operation is not affected by the attenuator. Detected voltage is due to local oscillator feed-through.

i. INJECTION OSCILLATOR OUTPUT. No provision is made for adjustment of the injection oscillator frequency. It may be desired, however, to check the frequency to see that it remains within the specified tolerance. Measured frequency at TP9, using an accurate counter or frequency meter, should be 100 kc ±0.02 per cent.

The injection oscillator r-f output level is set in the following manner after checking the Flat Voltmeter adjustment (paragraph 1d).

(1) Set FUNCTION to CAL 1.

(2) Set ATTENUATOR to 0 db.

(3) Adjust R87 for an output meter reading of 0 dbm.

j. MIXER I-F FINAL TUNING. Final adjustment of the mixer i-f section is described below:

(1) Set FUNCTION to SEL 250~.

(2) Set ATTENUATOR to 0 db.

(3) Set CAL 2 at mid-position.

(4) Feed a 100 kc signal at 0 db level to the input of the voltmeter.

(5) Tune voltmeter to the input signal, and peak output meter indication with the FINE tuning control.

(6) Tune L3, L4 and L5 for maximum output meter deflection.

k. CAL 2 RANGE. With a 0 db input signal and CAL 2 control set fully clockwise, output meter should read at least +3 db. Turning the CAL 2 control fully counterclockwise should bring the reading down to at least -3 db.

l. 2500 CYCLE BANDWIDTH CHECK. Although the 2500 ~ crystal filters are not adjustable, a complete calibration procedure should include a check of filter response. A method of determining bandwidth is described below.

(1) Set ATTENUATOR to 0 db.

(2) Set FUNCTION to SEL 2500 ~.

(3) Apply 0 db signal at 100 kc to input of voltmeter.

(4) Tune voltmeter to incoming signal, and adjust CAL 2 for 0 db output meter indication.

(5) Decrease input signal frequency from 100 kc, simultaneously changing the attenuator setting to keep the meter on scale. Record frequency of the -3 db and -60 db signal frequencies.

(6) Increase input signal frequency from 100 kc as above. Record frequency. The sum of the differences in frequency obtained in steps (5) and (6) is the nose width of the response curve. The 3 db bandwidth should not exceed 2.5 kc, and 60 db skirt width should not exceed 14 kc.

m. 250 CYCLE BANDWIDTH CHECK. Set FUNCTION selector to SEL 250 ~. Repeat paragraph l. The 3 db points should not exceed 250 cycles, and the 60 db points should not exceed 1400 cycles.

n. FILTER OUTPUT LEVEL MATCHING. To ensure proper input level to the IF strip, the crystal filter outputs are balanced in the following manner:

(1) Set FUNCTION to SEL 250 ~.

(2) Feed a 100 kc, 0 db signal to voltmeter input binding post. Tune carefully for maximum output meter deflection. Record meter reading.

(3) Set FUNCTION to SEL 250 ~.

(4) If reading varies from that recorded in the SEL 2500 ~, adjust R42 so that output indications are equal in both the SEL 2500 ~ and SEL 250 ~ positions.

o. ATTENUATOR STEP CHECK. The attenuator is checked using a signal generator, an external decade attenuator and an a-c VTVM accurate to 1 per cent. Procedure follows:

(1) Set ATTENUATOR at +20 db.

(2) Set FUNCTION at SEL 250~.

(3) Set LINE IMPEDANCE at 600Ω BRG.

(4) Apply a 20 kc signal at 20 db level to voltmeter; binding posts in unbalanced connection.

(5) Switch ATTENUATOR to +30 db. Output meter should read -10 db.

(6) Attenuate input signal 10 using decade attenuator, and switch voltmeter ATTENUATOR to +10 db. Output meter should read 0 db ±0.2 db.

(7) Attenuate input signal in 10 db steps while increasing voltmeter sensitivity in 10 db steps to -70 db. Output meter should remain accurate to ±0.2 db.

(8) Repeat steps (1) through (7) using a 620 kc signal.

p. SELECTIVE VOLTMETER RESPONSE. Using a signal generator, and an a-c VTVM, determine voltmeter linearity in selective operation using the following procedure:

(1) Set FUNCTION to SEL 250 ~.

(2) Set ATTENUATOR at 0 db.

(3) Apply 100 kc signal to voltmeter at 0 db.

(4) Tune and peak voltmeter to incoming signal.

(5) Adjust CAL 2 for 0 db on output meter.

(6) At 3 kc, 10 kc, 50 kc, 200 kc, 300 kc, 400 kc, 500 kc, and 620 kc, all at 0 db input level, record output meter readings. All readings should be 0 db, 0.5 db.

q. INTERMODULATION MEASUREMENT. Frequencies of 72.5 kc and 100 kc at 0 db level are fed to the voltmeter input through a mixing pad to determine intermodulation characteristics of the voltmeter. Proceed in the following manner:

(1) Set FUNCTION at SEL 2500 ~.

(2) Set ATTENUATOR at 0 db.

(3) Apply mixed frequencies to voltmeter.

(4) Adjust CAL 2 for 0 db output meter indication. Do not disturb CAL 2 or input signal generators for remainder of the test.

(5) Tune the voltmeter to the following frequencies; with ATTENUATOR at -60 db:

172.5 kc	245.0 kc
27.5 kc	127.5 kc
45.0 kc	272.5 kc

These are all sums or differences of the two input frequencies, and should measure less than -60 db on the output meter.

r. NOISE LEVEL. Normal noise in the instrument in SEL 2500~ position is about -20 db with CAL 2 fully clockwise. Most circuit noise is generated in the mixer stage and cannot be eliminated without deteriorating mixer performance. Noise may be read directly on the output meter.

2. MAINTENANCE

a. TROUBLE SHOOTING. Malfunctions can usually be determined rapidly using a sectionalizing system in conjunction with references to the equipment block diagram. First determine the correct operation of the power supply, checking the output voltage and ripple content. Excessive ripple and noise are due to power supply or decoupling network failure. Second, determine that the flat voltmeter operates correctly, since all other circuitry depends on its operation. Then approach the injection oscillator, mixer, i-f, and local oscillator sections. Occasionally coupling or decoupling capacitors leak only under conditions of high ambient temperature, and removal of the equipment from its cabinet may cause the fault to disappear. Microphonics are usually caused by poor switch contacts, loose solder joints or defective tubes. For resistance and voltage measurement, refer to Tables 3-2 and 3-3. For trouble-shooting tips see Table 3-1.

b. Care should be exercised in working on printed circuit boards. Remember that excessive heat will destroy the board and its circuitry. Use only enough heat, using some form of heat sink, to remove the component. Remount all components close to the board to avoid mechanical strain on leads.

TABLE 3-1 TROUBLE SHOOTING TIPS

TROUBLE	PROBABLE CAUSE	REMEDY
No Power, panel Switch "ON"	1. No line voltage. 2. Defective power cord. 3. Fuse F1 blown.	1. Check line voltage. 2. Replace cord. 3. Determine cause, replace fuse.
Fuse F1 Blown	1. Burned out diode in power supply. 2. Short in d-c supply. 3. Short in filament supply.	1. Replace diodes. 2. Determine cause, repair. 3. Determine cause, repair.
No meter reading in CAL 1 position	1. Injection oscillator failure. 2. Flat amplifier failure. 3. Power supply failure. 4. Function switch failure. 5. Wiring failure.	1. Check V9, Y1, replace if necessary. 2. Check V5, V6, V7, CR1, CR2, replace if necessary. 3. Check V11, V12, replace if necessary. 4. Check wafers contacts. Repair or replace. 5. Check osc. shielded output lead for short or open circuit.
No meter reading in CAL 2 position (CAL 1 functions properly) or No meter reading in SEL 2500~ and SEL 250~	1. Local oscillator failure. 2. Mixer failure. 3. I-F failure. 4. Function switch failure.	1. Check V10, CR4, CR5, CR6, replace if necessary. 2. Check V1, V2, replace if necessary. 3. Check V3, V4, replace if necessary. 4. Check wafers contacts, repair or replace.

Table 3-1 (Continued)

TROUBLE	PROBABLE CAUSE	REMEDY
Unable to set 0 db in CAL 2 position	1. Local oscillator output. 2. Detuned circuit in mixer. or I-F stages. 3. Low overall gain. 4. Injection oscillator output low.	1. Check CR4, CR5, CR6, replace if necessary. 2. Retune L3, L4, L5. 3. Check V1 through V7 replace if necessary. 4. Check V9, Y1, replace if necessary.
Excessive "no signal" meter indication	1. Faulty modulator. 2. Detuned modulator. 3. Loose oscillator or modulator cover.	1. Check, replace CR4, CR5, CR6, if required. (CR4, CR5 are a matched pair replacement). 2. Retune modulator. 3. Tighten cover.
Non linear output meter response	1. Defective meter diodes. 2. Defective meter.	1. Check or replace CR1, CR2. 2. Check or replace meter.
Unable to tune incoming signal (instrument operates correctly in CAL 2).	1. Open input circuit. 2. Defective bridging transformer. 3. Faulty LINE IMPEDANCE selector. 4. Faulty FUNCTION selector.	1. Check binding post and associated wiring. 2. Check or replace transformer. 3. Check contacts, repair or replace. 4. Check contacts, repair or replace.

Table 3-1 (Continued)

TROUBLE	PROBABLE CAUSE	REMEDY
Frequency Tuning Error	1. Local oscillator not tracking properly. 2. Loose local oscillator drum or variable capacitor coupling. 3. Local oscillator shift in frequency range.	1. Check adjust per paragraph 1g. 2. Check and repair. 3. Defective L11, C63, C64, C65.
Unequal readings in SEL 2500~ and SEL 250~	1. Filter output levels not matched. 2. Defective filter, excessive loss.	1. Adjust R42. 2. Replace FL1 or FL2.
Unequal reading in SEL 250~and CAL 2 (After proper calibration)	1. Loss of regulation in power supply.	1. Check or replace V11, V12, V13.
Poor regulation of power supply output	1. Line voltage too high or too low. 2. Defective tubes. 3. Open or leaky capacitor.	1. Check line voltage. 2. Check or replace V11, V12, V13. 3. Check or replace C80, C83, C82.
Power supply delivers excessive d-c output voltage.	1. Regulator V13. 2. Amplifier V12.	1. Check or replace. 2. Check or replace.
Power supply delivers too low a d-c output voltage.	1. Series tube V11. 2. Diodes CR7 to CR10.	1. Check or replace. 2. Check or replace.

Table 3-1 (Continued)

TROUBLE	PROBABLE CAUSE	REMEDY
No audio output	1. Audio amplifier V8. 2. Audio detector CR3. 3. Open audio control. 4. Defective phone jack.	1. Check or replace V8. 2. Check or replace CR3. 3. Check or replace R82. 4. Check or replace J4.

TABLE 3-2 RESISTANCE VALUES*

TEST POINT		RESISTANCE IN OHMS
Power Supply		
T3	1 and 2	inf.
T3	7 and 8	inf.
T3	6	0
T3	3 and 4	30K
T3	5	0.5 ohm Max.
V11	pin 1	560K
V11	pin 3 (TP1)	30K
V12	pin 1	560K
V12	pin 2	560K
V12	pin 3	18K
V12	pin 6	560K
V12	pin 7	95K
V12	pin 8	22K
V13	pins 1, 5	95K
V13	pins 2, 4, 7	0

TEST POINT		RESISTANCE IN OHMS
Mixer		
TP4		30K
TP6		250K
TP7		4.7K
TP8		inf.
Local Oscillator		
V10	pin 1	80K
V10	pin 2	100K
V10	pin 3	.3
V10	pin 6	30K
V10	pin 7	1 meg
V10	pin 8	1K
C57	(TP29)	30K
T2	1	4.6
T2	3	0

*Measurements made with 20K/ohms/volt multimeter

Table 3-2 (Continued)

TEST POINT		RESISTANCE IN OHMS	TEST POINT	RESISTANCE IN OHMS
Modulator			I-F Amplifier	
TP31		4700	TP13	2.2K
T2	1	4.6	TP14	30K approx.
T2	3 and 5	0	TP15	.11
T2	4	45	TP16	.11
T2	6	45	TP18	0 to 2.5K
			TP19	30K approx.
			TP20	.11

TABLE 3-3 VOLTAGE REFERENCE CHART*

TP NO. OR LOCATION	VOLTAGE	TP NO. OR LOCATION	VOLTAGE
Power Supply		Power Supply (Cont.)	
TP1	225 vdc +.25%	V12 pin 8	86 vdc
	(105 to 125 vac)	V13 pins 1, 5	87 vdc
TP2 and TP3	6.3 vac across terminals	Mixer-Cathode Follower	
V11 pin 5	350 vdc	TP4	225 vdc
V12 pin 1	210 vdc	TP5	6.3 vdc
V12 pins 2, 6	130 vdc	TP6	variable rms
V12 pin 3	132 vdc	TP7	34 vdc

*Measurements made with 20K/ohms/voltmeter

TABLE 3-3 VOLTAGE REFERENCE CHART* (Continued)

TP NO. OR LOCATION	VOLTAGE	TP NO. OR LOCATION	VOLTAGE
Mixer-Cathode Follower (Cont)		Flat Amplifier	
V1 pin 5	198 vdc	V5 pins 2, 7	0.6 vdc
V1 pin 6	145 vdc	V5 pin 5	131 vdc
V2 pin 2	2.4 vdc	V5 pin 6	62 vdc
V2 pins 5, 6 and 7	47 vdc	V6 pins 2, 7	1 vdc
I-F Amplifier		V6 pin 5	200 vdc
TP13	variable rms	V6 pin 6	100 vdc
TP14	225 vdc	V7 pins 2, 7	1.0 vdc
TP16	variable rms	V7 pin 5	155 vdc
TP19	225 vdc	V7 pin 6	100 vdc
TP20	variable rms	TP25, TP26	154 vdc
V3 pin 2	.5 vdc	Injection Oscillator	
V3 pin 5	74 vdc	TP10	225 vdc
V3 pin 6	40 vdc	V9 pin 3	.9 vdc
V4 pin 2	9.1 vdc R55 at max. resistance.	V9 pin 6	62 vdc
V4 pin 5	156 vdc	V9 pin 8	12 vdc
V4 pin 6	120 vdc		

*Measurements made with 20K/ohms/voltmeter

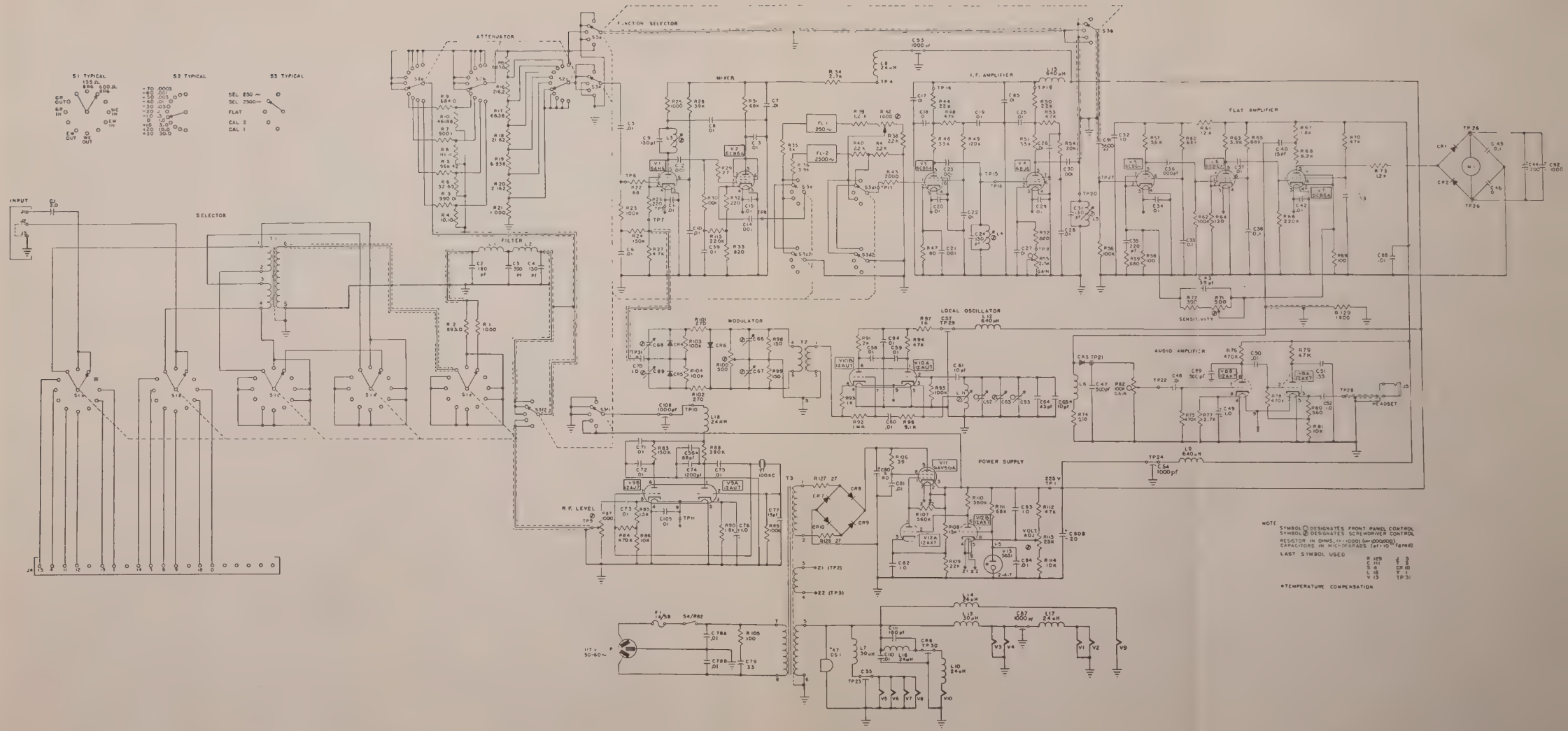


Figure 3-3. KS15538, L4 Schematic Diagram

SECTION IV

REPLACEABLE PARTS LIST

PARTS REPLACEMENT

Standard components have been used in this instrument whenever possible. Both standard and special components may be ordered direct from the factory.

When ordering parts always include:

1. Sierra Stock Number.
2. Circuit Reference and Commercial Description.
3. Name, Model and Serial Number of the Instrument.

Parts for this instrument, or further service information may be obtained from:

SIERRA ELECTRONIC DIVISION
Philco Corporation
3885 Bohannon Drive
Menlo Park, California 94025

Area Code 415
Telephone 326-2060
TWX 492-9224

1. INTRODUCTION

a. The following pages list the replaceable parts for the KS15538, L4.

REPLACEABLE PARTS LIST

2. TABULAR LISTING

Schem. Ref. No.	Description	Sierra Stock No.	Mfr.	Dwg. or Mfr. No.	Tot. Quan.
C1	CAPACITOR, 2.0 mf, .400 Vdcs, Metalized Paper Encapsulated	902420205	Texas	Type 31	1
C2	CAPACITOR, 180 pf, 500 Vdcw ±2% Silver Mica	902070181	Elmenco	CM-15E-181G	2
C3	CAPACITOR, 390 pf, 300 Vdcw ±2% Silver Mica	902070391	Elmenco	CM-15E-390	1
C4	CAPACITOR, 130 pf, 500 Vdcw ±2% Silver Mica	902070131	Elmenco	CM-15E-131G	4
C5	CAPACITOR, .01 mf, 150 Vdcw Disc Ceramic	901440103	Centralab	DDM-103	11
C6	Same as C5				
C7	CAPACITOR, .01 mf, 600 Vdcw ±20% Disc Ceramic	901420103	Centralab	DD6-103	27
C8	Same as C7				
C9	Same as C4				
C10	Same as C7				
C11	Same as C5				
C12	CAPACITOR, .001 mf, 500 Vdcw Disc Ceramic	901400102	Erie	801-.001	5
C13	Same as C7				
C14	Same as C12				
C15	Same as C5				
C16	Not Used				
C17	Same as C7				
C18	Same as C7				
C19	Same as C7				
C20	Same as C5				
C21	Same as C12				
C22	Same as C7				
C23	Same as C12				
C24	Same as C4				
C25	Same as C7				
C26	Same as C7				
C27	Same as C5				
C28	Same as C7				
C29	Same as C5				
C30	Same as C12				
C31	Same as C4				
C32	CAPACITOR, 1.0 mf, 400 Vdcw, Paper, P.C.	902420105	Tex Cap	Type 1017	1
C33	CAPACITOR, .1 mf, 400 Vdcw, Paper	901000001	Sprague	4SE-P10	4
C34	Same as C5				
C35	CAPACITOR, 220 pf, 300 Vdcw ±2% Silver Mica	902070221	Elmenco	CM-15E-221	1
C36	CAPACITOR, 1000 pf, 500 Vdcw ±5% Dur-Mica	901910102	Elmenco	DM-19-102J	1
C37	Same as C7				
C38	Same as C33				
C39	Same as C7				
C40	CAPACITOR, 15 pf, 500 Vdcw ±5% Silver Mica	902010150	Elmenco	CM-15C-150J	1
C41	CAPACITOR, .33 mf, 400 Vdcw Paper Tubular	901010334	Sprague	4SE-P33	2
C42	Same as C5				
C43	CAPACITOR, 39 pf, 500 Vdcw ±2% Silver Mica	902070390	Elmenco	CM-15E-390	1
C44	CAPACITOR, 200 mf, 6 Vdcw Electrolytic	902210207	Sprague	VL-1108	1
C45	Same as C33				
C46	Same as C33				
C47	CAPACITOR, 500 pf, Disc Ceramic	901410501	Centralab	DD501	2
C48	Same as C5				
C49	CAPACITOR, 1.0 mf, 50 Vdcw Electrolytic	902220105	Sprague	VL-1300	2
C50	Same as C7				
C51	Same as C41				
C52	CAPACITOR, 1.0 mf, 200 Vdcw Metalized Paper	902410105	Cornell-Dubilier	MPX2W1	4
C53	CAPACITOR, 1000 pf, 500 Vdcw Ceramic Feed Thru	902630102	Erie	327-102	7
C54	Same as C53				
C55	Same as C53				

REPLACEABLE PARTS LIST

Schem. Ref. No.	Description	Sierra Stock No.	Mfr.	Dwg. or Mfr. No.	Tot. Quan.
C56	CAPACITOR, 68 pf, 1200 Vdcw, ±2%, N330	901410680	Centralab	TCA68	1
C57	Same as C53				
C58	Same as C7				
C59	Same as C7				
C60	Same as C7				
C61	CAPACITOR, 10 pf ±2% NPO Tubular Hi Kap	901420100	Centralab	TCZ-10	1
C62	CAPACITOR, 10-55.7 pf, Variable	902810555	Radio Condenser	SS-12242-15	1
C63	CAPACITOR, 0.7-12 pf, NPO Glass Trimmer	903000120	JFD Electronics	VC-11G	5
C64	CAPACITOR, 43 pf, ±2% NPO Tubular Hi Kap	901410430	Centralab	TCZ-39	1
C65	CAPACITOR, 10 pf, ±2% N330 Tubular Hi Kap	901410100	Centralab	TCA-10	1
C66	Same as C63				
C67	Same as C63				
C68	Same as C63				
C69	Same as C63				
C70	Same as C52				
C71	Same as C7				
C72	Same as C7				
C73	Same as C5				
C74	CAPACITOR, 1200 pf, 500 Vdcw ±2% Silver Mica	902070122	Elmenco	CM-19E-122	1
C75	Same as C7				
C76	Same as C49				
C77	CAPACITOR, 15 pf, 500 Vdcw ±2% Silver Mica	902070150	Elmenco	CM-15E-150G	1
C78	CAPACITOR, 2X.01 mf, 500 Vdcw Ceramic Disc	901450103	Centralab	DD3-103	1
C79	CAPACITOR, .33 mf, 400 Vdcw, Metalized Paper	902410334	Cornell-Dubilier	MPX4P33	1
C80	CAPACITOR, 40-20 mf, 450 Vdcw Electrolytic	902210402	Sierra	SS-17672-1	1
C81	Same as C7				
C82	Same as C52				
C83	Same as C52				
C84	Same as C7				
C85	Same as C7				
C86	Same as C53				
C87	Same as C53				
C88	Same as C7				
C89	Same as C47				
C90	Not Used				
C91	CAPACITOR, 5600 pf, 600 Vdcw ±10% Paper Mylar Sidelead	901100562	Cornell-Dubilier	DPMS6D56	1
C92	CAPACITOR, 1000 mf, 6 Vdcw Electrolytic 85°C	902230108	Pyramid	TD-1000-6	1
C93	CAPACITOR, Variable	142171000	Sierra	SU-14217-1	1
C94	Same as C7				
C95	Not Used				
C96	Not Used				
C97	Not Used				
C98	Not Used				
C99	Not Used				
C100	Not Used				
C101	Not Used				
C102	Not Used				
C103	Not Used				
C104	Not Used				
C105	Same as C7				
C106	Not Used				
C107	Not Used				
C108	Same as C53				
C109	Not Used				

REPLACEABLE PARTS LIST

Schem. Ref. No.	Description	Sierra Stock No.	Mfr.	Dwg. or Mfr. No.	Tot. Quan.
C110	Same as C7				
C111	Same as C2				
CR1	DIODE, S10G, HD5000	910500010	Hughes	HD5000	2
CR2	Same as CR1				
CR3	DIODE, 1N34A Germanium	910500034	Sylvania	1N34A	2
CR4	DIODE, Germanium	910500028	Hughes	1812	2
CR5	Same as CR4				
CR6	Same as CR3				
CR7	RECTIFIER, 600 PIV 750 ma	910800008	Diode Inc.	D156	4
CR8	Same as CR7				
CR9	Same as CR7				
CR10	Same as CR7				
DS1	PILOT LIGHT, Bayonet Base	913800001	National Union	No. 47	1
F1	FUSE, 1.0 Amp. Delay	913200007	Bussman	MDL-1	1
FL1	CRYSTAL FILTER, 2.215 mc, 250 Cycle Bandpass	910100004	Sierra	SS-14486-1	1
FL2	CRYSTAL FILTER, 2.215 mc, 2500 Cycle Bandpass	910100005	Sierra	SS-14485-1	1
J1	BINDING POST, Insulated	915200012	General Radio	938-C	2
J2	Same as J1				
J3	BINDING POST, Grounding	915200013	General Radio	938-A	1
J4	CONNECTOR	914800003	Cinch	47B14515	1
J5	JACK, Telephone	914400003	Switchcraft	11-JAX	1
	BINDING POST, Insulators Pair	915200014	General Radio	938-BB	1
	BINDING POST, Spacer	915200011	General Radio	938-F	1
L1	INDUCTOR, 340 Microhenries	144221000	Sierra	SS-14422-1	2
L2	Same as L1				
L3	INDUCTOR, 30-38 Microhenries, Variable	127561000	Sierra	SS-12756-1	3
L4	Same as L3				
L5	Same as L3				
L6	INDUCTOR, 100 Microhenries	909000103	J. Millen	J-30-100	1
L7	INDUCTOR, 30 Microhenries, 1.5 Amp	127971000	Sierra	SS-12797-1	2
L8	INDUCTOR, 24 mh, 300 ma	909000097	Miller	4626	6
L9	INDUCTOR, 640 Microhenries	044931000	Sierra	SS-4493-1	3
L10	Same as L8				
L11	INDUCTOR, 20-41 Microhenries	127551000	Sierra	SS-12755-1	1
L12	Same as L9				
L13	Same as L7				
L14	Same as L8				
L15	Same as L9				
L16	Same as L8				
L17	Same as L8				
L18	Same as L8				
M1	METER, 0-1.0 ma dc	911800045	Beede	SS-14218-1	1
P1	POWER CORD with Plug	916400002	Cornish	3533	1

REPLACEABLE PARTS LIST

Schem. Ref. No.	Description	Sierra Stock No.	Mfr.	Dwg. or Mfr. No.	Tot. Quan.
R1	RESISTOR, 1000 ohm ±1%, 1/2W Deposited Carbon	907400080	Electra	DC-1/2C	1
R2	RESISTOR, 893.0 ohm ±1%, 1/2W Deposited Carbon	907400081	Electra	DC-1/2C	1
R3	RESISTOR, 990.01 ohm ±1%, 1/2W Deposited Carbon	907400093	Electra	DC-1/2C	1
R4	RESISTOR, 10.10 ohm ±1%, 1/2W Deposited Carbon	907400100	Electra	DC-1/2C	1
R5	RESISTOR, 968.42 ohm ±1%, 1/2W Deposited Carbon	907400094	Electra	DC-1/2C	1
R6	RESISTOR, 32.65 ohm ±1%, 1/2W Deposited Carbon	907400096	Electra	DC-1/2C	1
R7	RESISTOR, 900.1 ohm ±1%, 1/2W Deposited Carbon	907400095	Electra	DC-1/2C	1
R8	RESISTOR, 111.11 ohm ±1%, 1/2W Deposited Carbon	907400097	Electra	DC-1/2C	1
R9	RESISTOR, 684.0 ohm ±1%, 1/2W Deposited Carbon	907400098	Electra	DC-1/2C	1
R10	RESISTOR, 461.98 ohm ±1%, 1/2W Deposited Carbon	907400099	Electra	DC-1/2C	1
R11	Not Used				
R12	Not Used				
R13	Not Used				
R14	Not Used				
R15	RESISTOR, 683.8 ohm ±1%, 1/2W Deposited Carbon	907400022	Electra	DC-1/2C	1
R16	RESISTOR, 216.2 ohm ±1%, 1/2W Deposited Carbon	907400020	Electra	DC-1/2C	1
R17	RESISTOR, 68.38 ohm ±1%, 1/2W Deposited Carbon	907400018	Electra	DC-1/2C	1
R18	RESISTOR, 21.62 ohm ±1%, 1/2W Deposited Carbon	907400017	Electra	DC-1/2C	1
R19	RESISTOR, 6.838 ohm ±1%, 1/2W Deposited Carbon	907400089	Electra	DC-1/2C	1
R20	RESISTOR, 2.162 ohm ±1%, 1/2W Deposited Carbon	907400090	Electra	DC-1/2C	1
R21	RESISTOR, 1.000 ohm ±1%, 1/2W Deposited Carbon	907400091	Electra	DC-1/2C	1
R22	RESISTOR, 68 ohm ±10%, 1/2W Fixed Composition	905200680	Allen Bradley	Type EB	1
R23	RESISTOR, 100,000 ohm ±10%, 1/2W Fixed Comp.	905200104	Allen Bradley	Type EB	6
R24	RESISTOR, 150,000 ohm ±10%, 1/2W Fixed Comp.	905200154	Allen Bradley	Type EB	1
R25	RESISTOR, 1,000 ohm ±5%, 1/2W Fixed Composition	905000102	Allen Bradley	Type EB	3
R26	RESISTOR, 220 ohm ±5%, 1/2W Fixed Composition	905000221	Allen Bradley	Type EB	2
R27	RESISTOR, 4700 ohm ±5%, 1/2W Fixed Composition	905000472	Allen Bradley	Type EB	1
R28	RESISTOR, 39,000 ohm ±5%, 1/2W Fixed Composition	905000393	Allen Bradley	Type EB	1
R29	RESISTOR, 27 ohm ±10%, 1/2W Fixed Composition	905200270	Allen Bradley	Type EB	1
R30	Same as R23				
R31	RESISTOR, 68,000 ohm ±10%, 1/2W Fixed Comp.	905200683	Allen Bradley	Type EB	3
R32	Same as R26				
R33	RESISTOR, 820 ohm ±5%, 1/2W Fixed Composition	905000821	Allen Bradley	Type EB	2
R34	RESISTOR, 2,700 ohm ±5%, 1/2W Fixed Composition	905000272	Allen Bradley	Type EB	2
R35	RESISTOR, 3,000 ohm ±5%, 1/2W Fixed Composition	905000302	Allen Bradley	Type EB	1
R36	RESISTOR, 3,900 ohm ±5%, 1/2W Fixed Composition	905000392	Allen Bradley	Type EB	1
R37	Not Used				
R38	RESISTOR, 2,200 ohm ±5%, 1/2W Fixed Composition	905000222	Allen Bradley	Type EB	3
R39	RESISTOR, 1,200 ohm ±5%, 1/2W Fixed Composition	905000122	Allen Bradley	Type EB	1
R40	Same as R38				
R41	Same as R38				
R42	POTENTIOMETER, 1,000 ohm, Type UPE-70	907900105	CTS	32275	2
R43	RESISTOR, 2,000 ohm ±5%, 1/2W Fixed Composition	905000202	Allen Bradley	Type EB	2
R44	RESISTOR, 22,000 ohm ±10%, 1/2W Fixed Comp.	905200223	Allen Bradley	Type EB	2
R45	Not Used				
R46	RESISTOR, 33,000 ohm ±10%, 1/2W Fixed Comp.	905200333	Allen Bradley	Type EB	2
R47	RESISTOR, 180 ohm ±5%, 1/2W Fixed Composition	905000181	Allen Bradley	Type EB	1
R48	RESISTOR, 47,000 ohm ±10%, 1/2W Fixed Comp.	905200473	Allen Bradley	Type EB	4
R49	RESISTOR, 120,000 ohm ±10%, 1/2W Fixed Comp.	905200124	Allen Bradley	Type EB	2
R50	Same as R44				
R51	Same as R46				
R52	Same as R33				
R53	Same as R48				
R54	Same as R49				
R55	POTENTIOMETER, 2,500 ohm 2W Composition	907900152	CTC	HT321 35774	1
R56	Same as R23				

REPLACEABLE PARTS LIST

Schem. Ref. No.	Description	Sierra Stock No.	Mfr.	Dwg. or Mfr. No.	Tot. Quan.
R57	RESISTOR, 5,600 ohm ±10%, 1/2W Fixed Composition	905200562	Allen Bradley	Type EB	1
R58	RESISTOR, 100 ohm ±5%, 1/2W Fixed Composition	905000101	Allen Bradley	Type EB	2
R59	RESISTOR, 680 ohm ±5%, 1/2W Fixed Composition	905000681	Allen Bradley	Type EB	1
R60	Same as R31				
R61	RESISTOR, 12,000 ohm ±10%, 1/2W Fixed Comp.	905200123	Allen Bradley	Type EB	1
R62	Same as R23				
R63	RESISTOR, 3,900 ohm ±10%, 1W Fixed Composition	905600392	Allen Bradley	Type EB	1
R64	RESISTOR, 120 ohm ±5%, 1/2W Fixed Composition	905000121	Allen Bradley	Type EB	1
R65	Same as R31				
R66	RESISTOR, 220,000 ohm ±10%, 1/2W Fixed Comp.	905200224	Allen Bradley	Type EB	2
R67	RESISTOR, 1,800 ohm ±5%, 1/2W Fixed Composition	905000182	Allen Bradley	Type EB	3
R68	RESISTOR, 8,200 ohm ±5%, 1W Fixed Composition	905400822	Allen Bradley	Type EB	1
R69	Same as R58				
R70	Same as R48				
R71	POTENTIOMETER, 500 ohm, 1/2W, Taper 1	907900100	Stackpole	LH61	1
R72	RESISTOR, 390 ohm ±5%, 1/2W Fixed Composition	905000391	Allen Bradley	Type EB	1
R73	RESISTOR, 1,200 ohm ±10%, 1/2W Fixed Composition	905200122	Allen Bradley	Type EB	1
R74	RESISTOR, 270 ohm ±10%, 1/2W Fixed Composition	905200271	Allen Bradley	Type EB	1
R75	RESISTOR, 470,000 ohm ±10%, 1/2W Fixed Comp.	905200474	Allen Bradley	Type EB	4
R76	Same as R75				
R77	Same as R34				
R78	Same as R75				
R79	Same as R48				
R80	RESISTOR, 560 ohm ±5%, 1/2W Fixed Composition	905000561	Allen Bradley	Type EB	1
R81	RESISTOR, 10,000 ohm ±10%, 1/2W Fixed Composition	905200103	Allen Bradley	Type EB	2
R82	POTENTIOMETER, 100,000 ohm, 2W Comp. Switch Section	907900071	Sierra	SS-393-3-45	1
R83	RESISTOR, 150,000 ohm ±5%, 1/2W Fixed Comp.	905000154	Allen Bradley	Type EB	1
R84	Same as R75				
R85	RESISTOR, 1,500 ohm ±5%, 1/2W Fixed Composition	905000152	Allen Bradley	Type EB	1
R86	Same as R81				
R87	Same as R42				
R88	RESISTOR, 390,000 ohm ±5%, 1/2W Fixed Comp.	905000394	Allen Bradley	Type EB	1
R89	Same as R23				
R90	Same as R67				
R91	Same as R43				
R92	RESISTOR, 1 Meg. ohm ±10%, 1/2W Fixed Comp.	905200105	Allen Bradley	Type EB	1
R93	Same as R25				
R94	RESISTOR, 47,000 ±5%, 1/2W Fixed Composition	905000473	Allen Bradley	Type EB	1
R95	Same as R23				
R96	RESISTOR, 9,100 ohm ±5%, 1/2W Fixed Composition	905000912	Allen Bradley	Type EB	1
R97	Same as R25				
R98	RESISTOR, 150 ohm ±5%, 1/2W Fixed Composition	905000151	Allen Bradley	Type EB	2
R99	Same as R98				
R100	POTENTIOMETER, 500 ohm, 1/4W Composition (Lug Terminals)	907900102	Allen Bradley	Type R	1
R101	RESISTOR, 270 ohm ±5%, 1/2W Fixed Composition	905000271	Allen Bradley	Type EB	1
R102	Same as R101				
R103	RESISTOR, 100,000 ohm ±5%, 1/2W Fixed Comp.	905000104	Allen Bradley	Type EB	2
R104	Same as R103				
R105	RESISTOR, 100 ohm ±10%, 1/2W Fixed Composition	905200101	Allen Bradley	Type EB	1
R106	RESISTOR, 39 ohm ±10%, 1/2W Fixed Composition	905200390	Allen Bradley	Type EB	1
R107	RESISTOR, 560,000 ohm ±5%, 1/2W Fixed Comp.	905000564	Allen Bradley	Type EB	2
R108	RESISTOR, 15,000 ohm ±5%, 2W Fixed Composition	905800153	Allen Bradley	Type HB	1
R109	RESISTOR, 22,000 ohm ±5%, 2W Fixed Composition	905800223	Allen Bradley	Type EB	1
R110	Same as R107				

REPLACEABLE PARTS LIST

Schem. Ref. No.	Description	Sierra Stock No.	Mfr.	Dwg. or Mfr. No.	Tot. Quan.
R111	RESISTOR, 68,000 ohm ±5%, 1W Fixed Composition	905400683	Allen Bradley	Type GB	1
R112	RESISTOR, 47,000 ohm ±5%, 1W Fixed Composition	905400473	Allen Bradley	Type GB	1
R113	POTENTIOMETER, 25,000 ohm, Printed Circuit Type, Taper 1	907900103	Stackpole	LH61	1
R114	RESISTOR, 10,000 ohm ±5%, 1/2W Fixed Composition	905000103	Allen Bradley	Type EB	1
R115	Same as R66				
R116	Not Used				
R117	Not Used				
R118	Not Used				
R119	Not Used				
R120	Not Used				
R121	Not Used				
R122	Not Used				
R123	Not Used				
R124	Not Used				
R125	Not Used				
R126	Not Used				
R127	RESISTOR, 27 ohm ±5%, 1W Fixed Composition	905400270	Allen Bradley	Type GB	2
R128	Same as R127				
R129	Same as R67				
S1	SWITCH, Selector	911200057	Sierra	SS-14204-1	1
S2	SWITCH, Selector, 3 Pole, 11 Position, Four Section	911200056	Sierra	SS-14205-1	1
S3	SWITCH, Selector, 9 Pole, 5 Position, Six Section	911200046	Sierra	SS-12455-1	1
S4	SWITCH, On-Off, (Part of R82 Potentiometer)	907900071	Sierra	SS-393-3-45	1
T1	TRANSFORMER, 600-135 ohm/2,000 ohm 1 kc to 620 kc	141893000	Sierra	SU-14189-3	1
T2	TRANSFORMER, 2:1 turns ratio, Frequency Range 2.2 mc to 2.9 mc	141592000	Sierra	SU-14159-2	1
T3	TRANSFORMER, Power, Sec.#1:250Vrms, at 75 ma; DC Sec.#2:6.3Vrms at 4A Sec.#3:6.3 Vrms at 1.6A Primary 117Vrms 50/1,000 cps (Per SS-12403-1)	910000033	Foster	6821	1
V1	VACUUM TUBE, Sharp Cut-Off Pentode	910700074	Sierra	6AH6	1
V2	VACUUM TUBE, Sharp Cut-Off Pentode	910700059	Sierra	6CB6A	5
V3	Same as V2				
V4	VACUUM TUBE, Sharp Cut-Off Pentode	910700075	Sierra	6BJ6	1
V5	Same as V2				
V6	Same as V2				
V7	Same as V2				
V8	VACUUM TUBE, Twin Triode	910700069	Sierra	12AX7	2
V9	VACUUM TUBE, Twin Triode	910700052	Sierra	12AU7	2
V10	Same as V9				
V11	VACUUM TUBE, Pentode	910700076	Sierra	6AV5GA	1
V12	Same as V8				
V13	GAS TUBE, Voltage Reference	910700015	Sierra	5651	1
XDS1	PILOT LIGHT, Holder	914200008	Dialco	7-04	1
XF1	FUSE HOLDER	913400001	Littelfuse	342003	1
XV1	TUBE SOCKET, 7 pin miniature for printed board	914000036	Methode	P455	8
XV2	Same as XV1				

REPLACEABLE PARTS LIST

Schem. Ref. No.	Description	Sierra Stock No.	Mfr.	Dwg. or Mfr. No.	Tot. Quan.
XV3	Same as XV1				
XV4	Same as XV1				
XV5	Same as XV1				
XV6	Same as XV1				
XV7	Same as XV1				
XV8	TUBE SOCKET, 9 Pin Noval For Printed Board	914000037	Methode	P465	3
XV9	Same as XV8				
XV10	TUBE SOCKET, Turret	914000032	Vector Electronic	8N12T	1
XV11	TUBE SOCKET, Octal for Printed Board	914000035	Elco	611PH-1/16	1
XV12	Same as XV8				
XV13	Same as XV1				
Y1	CRYSTAL, Quartz 100 kc, .02%	912200009	Bliley Electric	SS-13109-1	1
YX1	CRYSTAL, Holder, Ceramic	914200021	Johnson	126-105	1
-	SHORTING LINK	915200007	General Radio	938-L	1